2631 #6

PATENT
P-3053-US

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

APPLICANT(S): EDLIS, Ofir et al.

SERIAL NO: 09/780,470 EXAMINER: Unknown

FILED: February 12, 2001 GROUP ART UNIT: 2631

FOR: SEARCHING IN DUAL-MODE COMMUNICATIONS SYSTEM

ASSISTANT COMMISSIONER OF PATENTS
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CLAIM FOR PRIORITY

Sir:

Applicant(s) hereby claims priority under 35 U.S.C. Section 119 based on Israeli Application No. 134512 filed February 13, 2000.

A certified copy of the priority document is submitted herewith.

Respectfully submitted,

Mark S. Cohen
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Registration No.

Dated: June 7, 2001

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מדינת ישראל
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משרד המשפטים
לשכת הפטנטים

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particulars are specified on the

first page of the annex.

זאת לתעודה כי רצופים

בזה העתקים נכונים של

המסמכים שהופקדו

לכתחילה עם הבקשה

לפטנט לפי הפרטים

הרשומים בעמוד הראשון

של הנספח.

CERTIFIED COPY OF PRIORITY DOCUMENT

This 10-05-2001 היום

לשרי
רשם הפטנטים

Commissioner of Patents

נתאשר
Certified

חוק הפטנטים, התשכ"ז - 1967
PATENTS LAW, 5727 - 1967

בקשה לפטנט - Application For Patent

לשימוש הלשכה
For Office Use

מספר: Number	134512
תאריך: Date	13 -02- 2000
הוקדם/נדחה Ante/Post-dated	

אני, (שם המבקש, מענו ולגבי גוף מאוגד - מקום התאגדותו)
I, (Name and address of applicant, and in case of body corporate - place of incorporation)

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בעל אמצאה מכח **הדין** ששמה הוא
Owner, by virtue of **the law** of an invention the title of which is

(בעברית)
(Hebrew)
רכישת אות CDMA באמצעות עיבוד ברקע

(באנגלית)
(English)
OFFLINE ACQUISITION METHOD FOR CDMA

*בקשת חלוקה - Application of Division	*בקשת פטנט מוסף - Application for Patent Addition	דרישה דין קדימה Priority Claim		
*מבקשת פטנט from Application	*לבקשה/לפטנט to Patent/Appl.	מספר\סימן Number/Mark	תאריך Date	מדינת האגוד Convention Country
מס' No.....	מס' No.....			
מיום dated.....	מיום dated.....			
יפוי-כח: POA:				
הוגש בענין filed in case **P.A.120555**				
המען למסירת מסמכים בישראל Address for Service in Israel		היום 13 לחודש פברואר שנת 2000 This 13 of February of the year 2000		
איתן, פרל, לצר וכהן-צדק **עורכי דין, עורכי פטנטים ונוטריון** **רח' שנקר 7, הרצליה 46725**				
חתימת המבקש Signature of the Applicant				לשימוש הלשכה For Official Use
עבור המבקש, For the Applicant,				
איתן, פרל, לצר וכהן-צדק **EITAN, PEARL, LATZER & COHEN-ZEDEK** **P-3053-IL**				

טופס זה, כשהוא מוטבע בחותם לשכת הפטנטים ומושלם במספר ובתאריך ההגשה, הנו אישור להגשת הבקשה שפרטיה רשומים לעיל.
This form, impressed with the Seal of the Patent Office and indicating the number and date of filing, certifies the filing of the application the particulars of which are set out above.

* מחק את המיותר Delete whatever is inapplicable

OFFLINE ACQUISITION METHOD FOR CDMA

רכישת אות CDMA באמצעות עיבוד ברקע

Eitan, Pearl, Latzer & Cohen-Zedek

P-3053-IL

FIELD OF THE INVENTION

The present invention relates to code division multiple access (CDMA) communications, in general, and to acquisition of a pseudo noise (PN) sequence, in particular.

BACKGROUND OF THE INVENTION

In order to receive a code division multiple access (CDMA) signal, the pseudo noise (PN) sequence must be acquired ("acquisition"). The straightforward implementation for acquisition is trial-and-error, meaning selecting one of the 2^{15}-1 possible PN sequences and trying to find a correlation with the received signal. If a correlation is found (passed a predefined threshold), then the next step is to synchronize the channel, also known as acquiring the system time. If a correlation is not found (i.e. did not pass the threshold), then the next possible PN sequence is tested. If no correlation is found with any of the 2^{15}-1 possible PN sequences, then the threshold is reduced and all hypotheses are retested. If even the lowest permitted threshold does not yield a correlation, then one tries to acquire an Advanced Mobile Phone Service (AMPS) signal, as described in TIA/EIA IS-95-B, "Mobile Station – Base Station Compatibility Standard for Dual-Mode Wideband Spread Spectrum Cellular System". The maximum time allowed by the standard to get into "idle" mode (which is acquisition, sync and paging) is 15 seconds.

The standard does not define a hand off from analog to CDMA due to the long acquisition time of CDMA. The only scenario for transferring from analog to CDMA is when the analog signal

has been lost. In that case, the standard defines switching to System Determination Mode and then CDMA re-acquisition.

If CDMA acquisition fails and an analog signal cannot be found, the mobile handset is in "no service" mode. In that mode, the MCU turns off the mobile handset and continues to look for either CDMA or an analog signal.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be understood and appreciated more fully from the following detailed description taken in conjunction with the appended drawings in which:

Fig. 1 is a schematic illustration of the CDMA receive path, which is helpful in understanding the present invention;

Fig. 2 is a schematic illustration of the CDMA receive path, with an indication of a point for snap recording, according to a preferred embodiment of the present invention;

Fig. 3 is a schematic illustration of the CDMA receive path, with an indication of a point for snap recording, according to another preferred embodiment of the present invention;

Figs. 4 and 5 are schematic illustrations of the CDMA receive path, indicating configurations for snap processing when the snap recording point is as shown in Figs. 2 and 3, respectively;

Fig. 6 is a flowchart illustration of a method for handing off from analog to CDMA "idle" mode, according to a preferred embodiment of the present invention;

Fig. 7 is a schematic illustration of the WBD frame structure, helpful in understanding the present invention; and

Fig. 8 is a flowchart illustration of an analog-to-CDMA IDLE hand-off, according to a preferred embodiment of the present invention.

DETAILED DESCRIPTION OF THE PRESENT INVENTION

The present invention is directed to a method of code division multiple access (CDMA) offline acquisition, in which the acquisition is split into two stages: a) recording the snap of a CDMA signal; and b) CDMA acquisition by processing the recorded snap. The radio frequency (RF) should be on only while the CDMA signal is being recorded. During the processing of the recorded data, both the RF and the CDMA receiver can be either off or switched to any other mode (for example, analog).

The method of the present invention results in a faster acquisition process than the trial-and-error method described in the background. It also enables a reduction in power consumption. Furthermore, it enables one to look for a CDMA carrier while receiving another carrier, with minimal effect on the current received carrier, for example, recording a CDMA snap while receiving Advance Mobile Phone Service (AMPS).

The offline acquisition process should be completed in a very short period of time. The snap recording should be quick in order to minimize the time required for the RF for receiving the CDMA signal, in order to reduce power consumption and in order not to lose synchronization with another service the mobile handset might be connected to. The snap processing should be quick so that in the case of successful acquisition, the handset will be as close as possible to the location as well as the conditions in which the snap was taken. Another reason that the snap processing should be quick is to enable a quick retry in the case where no CDMA signal was found. A quick retry may assist in determining whether no signal was found due to fading or due to lack of CDMA service at that location.

In order to avoid the need of a real-time acquisition after a CDMA signal was found by offline acquisition, it is recommended to activate a PN generator at the same time that the snap recording is beginning. That way, the PN shift found by the offline acquisition is exactly the shift that the PN generator should be shifted by in order to be synchronized with the CDMA carrier found by the offline acquisition.

Reference is now made to Fig. 1, which is a schematic illustration of the CDMA receive path, which is helpful in understanding the present invention. According to a preferred embodiment of the present invention, the snap record point is between the ADC output and the digital processing input, as shown in Fig. 2, to which reference is now made. The CDMA snap is recorded to a memory 55 such as read-access memory (RAM) or flash memory. In this embodiment, the power consumption can be improved by turning off both the digital processing unit 60 and the CDMA rake receiver and acquisition engine 80 while recording the CDMA snap. If acquisition can be accomplished with a lower data rate than the data rate provided by the ADC 50, then the ADC clock frequency can be reduced, thus reducing power consumption. Alternatively, a sampling unit (not shown) is implemented between the ADC 50 and the memory 55, which truncate the data rate to the required rate. The two options (clock frequency reduction or sampling unit) enable a reduction in the size of memory 55, as well.

According to another preferred embodiment of the present invention, the snap record point is between the digital processing output and the rake receiver input, as shown in Fig. 3, to which reference is now made. The CDMA snap is recorded to a memory 65 such as read-access memory (RAM) or flash memory. In this embodiment, the power consumption can be improved by turning off the CDMA rake receiver and acquisition engine 80 while recording the CDMA snap. If acquisition can be accomplished with a lower data rate than the data rate provided by the digital processing unit 60, then the ADC clock frequency and the digital processing clock frequency can be reduced, thus reducing power consumption. Alternatively, a sampling unit (not shown) is implemented between the digital processing unit 60 and the memory 65, which truncate the data rate to the required rate. The two options (clock frequency reduction or sampling unit) enable a reduction in the size of memory 65, as well. Analog processing 40 preferably includes analog filtering, a DC remover, and AGC or any other suitable analog processing circuitry. Digital processing 60 preferably includes digital filtering, interpolating, or any other suitable digital processing circuitry.

According to a preferred embodiment of the present invention, the CDMA snap is processed using the method described in PCT Patent Application WO 98/44670 published October 8, 1998, entitled "A CODE SYNCHRONIZATION UNIT AND METHOD", which is incorporated herein by reference. The method uses a fast Hadamard transform (FHT) which determines the quality, in accordance with a metric, of each of a set of possible PN loadings.

According to another preferred embodiment of the present invention, the CDMA is processed as known in the art, but the source of the data for the processing is not the real-time CDMA signal but rather the recorded CDMA snap. Reference is now made to Figs. 4 and 5, which are schematic illustrations of the CDMA receive path, indicating configurations for snap processing when the snap recording point is as shown in Figs. 2 and 3, respectively. If the snap recording point is between the ADC output and the digital processing input (Fig. 2), then as shown in Fig. 4, the ADC 50 should be disconnected from the digital processing unit 60 when processing the recorded snap. The input to the digital processing unit 60 for snap processing is the memory 55 in which the CDMA snap has been stored. If the snap recording point is between the digital processing output and the CDMA rake receiver input (Fig. 3), then as shown in Fig. 5, the digital processing unit 60 should be disconnected from the CDMA rake receiver and acquisition engine 80.

There are a number of advantages to processing a recorded CDMA snap as opposed to processing a real-time CDMA signal. Firstly, there is power saving since the RF, the analog components and some of the digital components can be turned off while the acquisition engine 80 is working. Secondly, processing a recorded CDMA snap is faster than processing a real-time CDMA signal. Since the source of the acquisition engine 80 is not real-time data, the acquisition engine 80 can be driven by a faster clock and the same processing can be accomplished in a shorter period of time. Thirdly, the RF can be set to receive another carrier (for example, analog, GSM, etc.) while the acquisition process is being performed.

As described hereinabove, the standard does not define a hand off from analog to CDMA. Offline acquisition can provide a solution for this problem, by following the steps shown in Fig. 6, to

which reference is now made. Fig. 6 is a flowchart illustration of a method for handing off from analog to CDMA "idle" mode, according to a preferred embodiment of the present invention. It will be appreciated that the time in which the analog receiving is terminated is very short (the RF transactions and the CDMA snap recording), therefore the analog recover is very easy.

In order to reduce the interference to the WBD while recording the CDMA snap (or not to interfere with the WBD at all), the WBD "shut down" can be set to a certain location, which is more "convenient". The WBD frame structure is shown in Fig. 7, to which reference is now made. An odd AMPS phone should receive the 5 odd repetitions, while an even AMPS phone should receive the 5 even repetitions. The mobile handset should decide what data is sent by the base station from the 5 repetitions received and using a certain criteria, for example, majority voting.

Upon receiving a good WBD signal, the mobile handset might be able to decide what was the data sent by the base station using fewer than 5 repetitions. In that case, the mobile handset can use the "Unused Repetitions" for recording the CDMA snap. Criteria for determining whether a good WBD signal is received should be used. Based on the criteria the mobile may decide whether the WBD reception may be stopped temporarily. Parameters that may be considered for the criteria include the quality of the WBD signal, and/or the time required for recording the CDMA snap, including the RF switching from analog to CDMA, AGC stabilization time, the snap length, and the RF switching from CDMA to analog. Commonly, the time required for switching the RF from mode to mode is approximately 5 milliseconds, while the snap could be less than 3 milliseconds. In the event that the "Unused Repetitions" time is not enough time for CDMA snap recording, and by assuming that the good AMPS conditions won't be changed during the next frame, it is possible to use the first repetitions of a given frame for WBD reception and the last repetitions of the next frame for WBD reception. That yields "Unused Repetitions" at the end of the given frame and at the beginning of the next frame. The result is a CDMA snap recording duration of two "Unused Repetitions" time.

Some of the messages sent by the base station last for more than one frame (such as an incoming call message). In some cases, already after receiving the first frame it is apparent that the

current message is not destined for the mobile handset. In those cases, there may be a whole frame or more for CDMA snap recording.

The solution presented above can be expanded to every mode to CDMA "idle" hand off in which the existing mode of communication cannot provide data on the CDMA system and therefore cannot initiate an "idle" hand off. It may also be extended to hand off while in an analog conversation (i.e., hard hand off). In such a case the conversation should be switched from the analog system to the CDMA system. The analog conversation may be interrupted for approximately 1 second. An analog-to-CDMA IDLE hand-off flowchart is seen with reference to Fig. 8.

It will be appreciated by persons skilled in the art that the present invention is not limited by what has been particularly shown and described herein above. Rather the scope of the invention is defined by the claims that follow:

CLAIMS

1. A CDMA device substantially as described hereinabove.

2. A CDMA device substantially as illustrated in any of the drawings.

3. An offline acquisition method substantially as described hereinabove.

4. An offline acquisition method substantially as illustrated in any of the drawings.

For the Applicant

Eitan, Pearl, Latzer & Cohen-Zedek

Lawyers, Patent Attorneys & Notaries

P-3053-IL

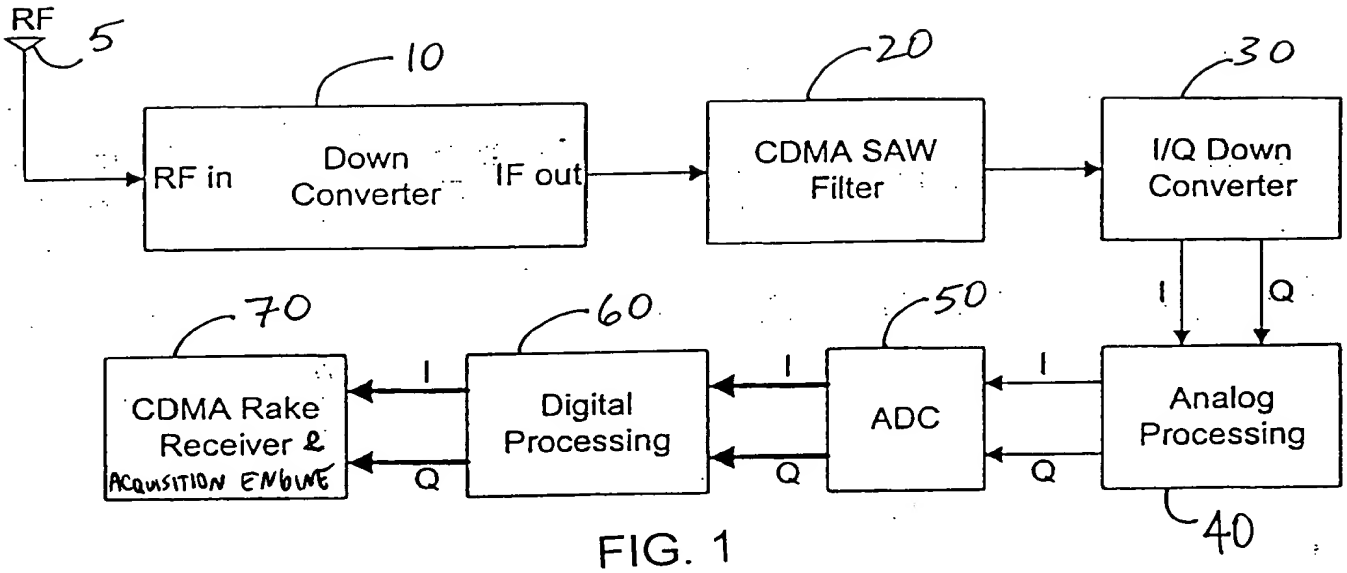
RF
5
10
RF in
Down Converter
IF out
20
CDMA SAW Filter
30
I/Q Down Converter
I
Q
70
CDMA Rake Receiver & ACQUISITION ENGINE
60
Digital Processing
50
ADC
Analog Processing
40

FIG. 1

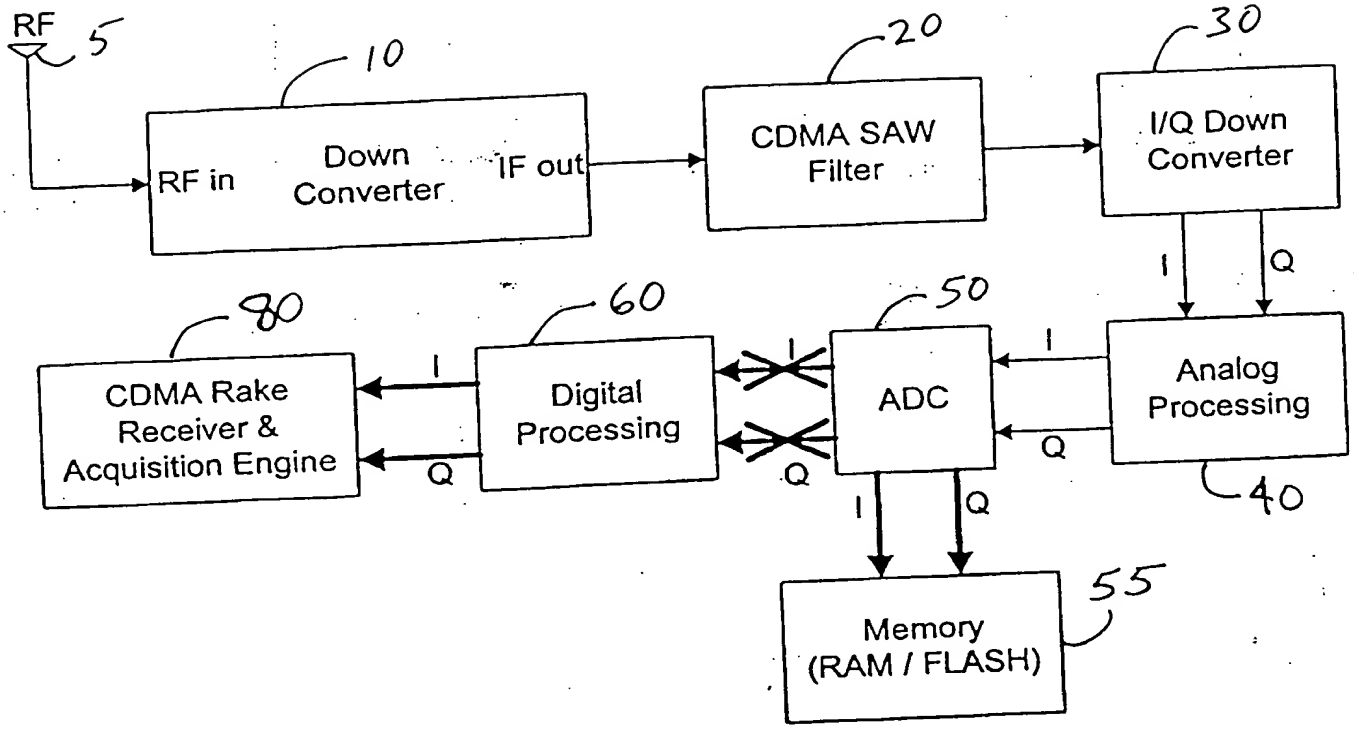
RF
5
10
RF in
Down Converter
IF out
20
CDMA SAW Filter
30
I/Q Down Converter
I
Q
80
CDMA Rake Receiver & Acquisition Engine
60
Digital Processing
50
ADC
Analog Processing
40
55
Memory (RAM / FLASH)

FIG. 2

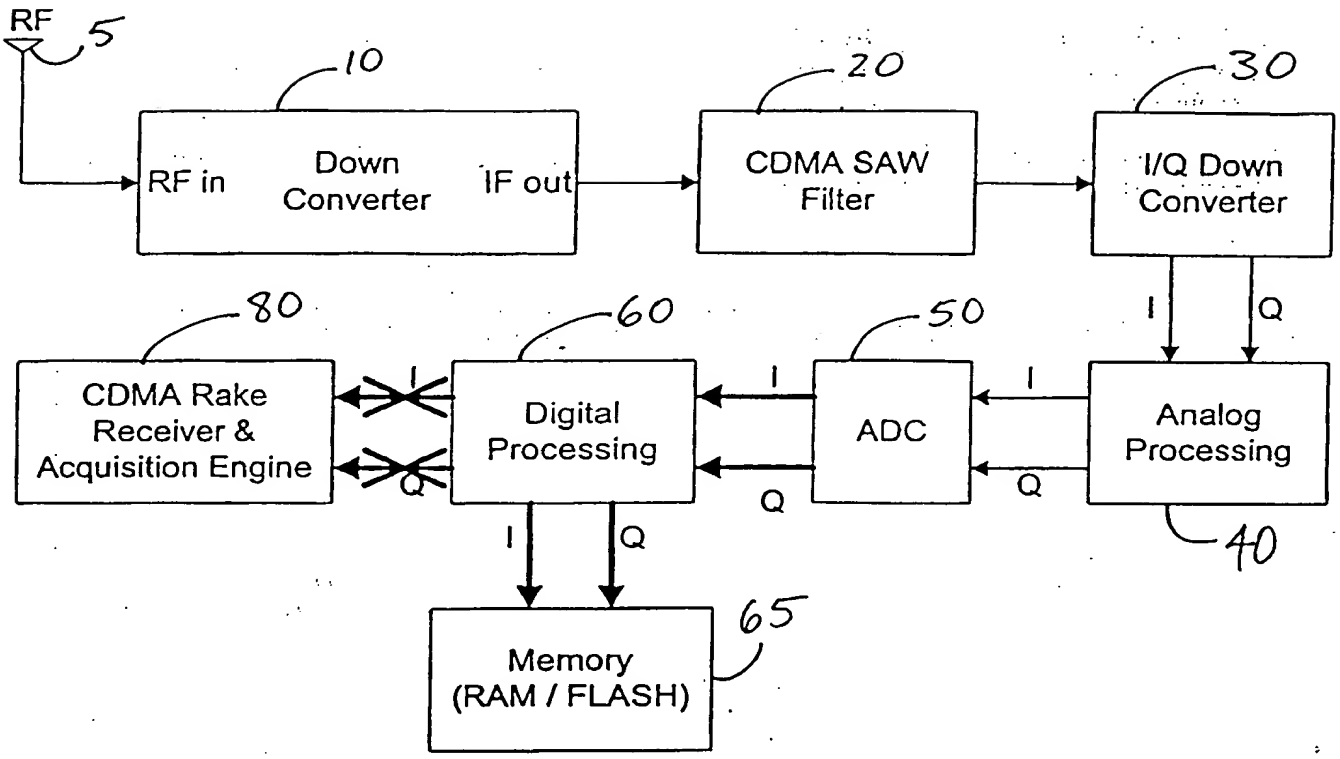
RF
5
10
RF in
Down Converter
IF out
20
CDMA SAW Filter
30
I/Q Down Converter
I
Q
80
CDMA Rake Receiver & Acquisition Engine
60
Digital Processing
50
ADC
Analog Processing
40
I
Q
65
Memory (RAM / FLASH)

FIG. 3

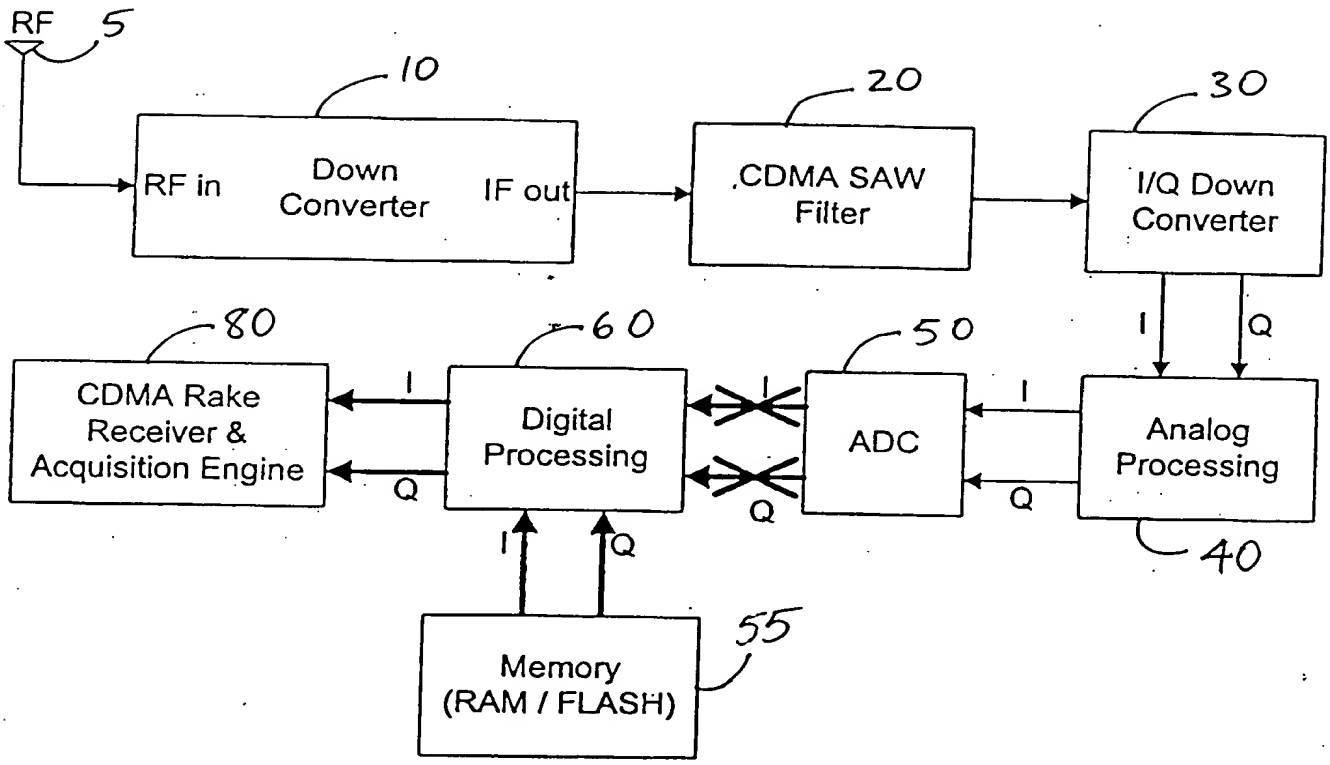
RF
5
10
RF in
Down Converter
IF out
20
CDMA SAW Filter
30
I/Q Down Converter
I
Q
80
CDMA Rake Receiver & Acquisition Engine
60
Digital Processing
50
ADC
Analog Processing
40
I
Q
55
Memory (RAM / FLASH)

FIG. 4

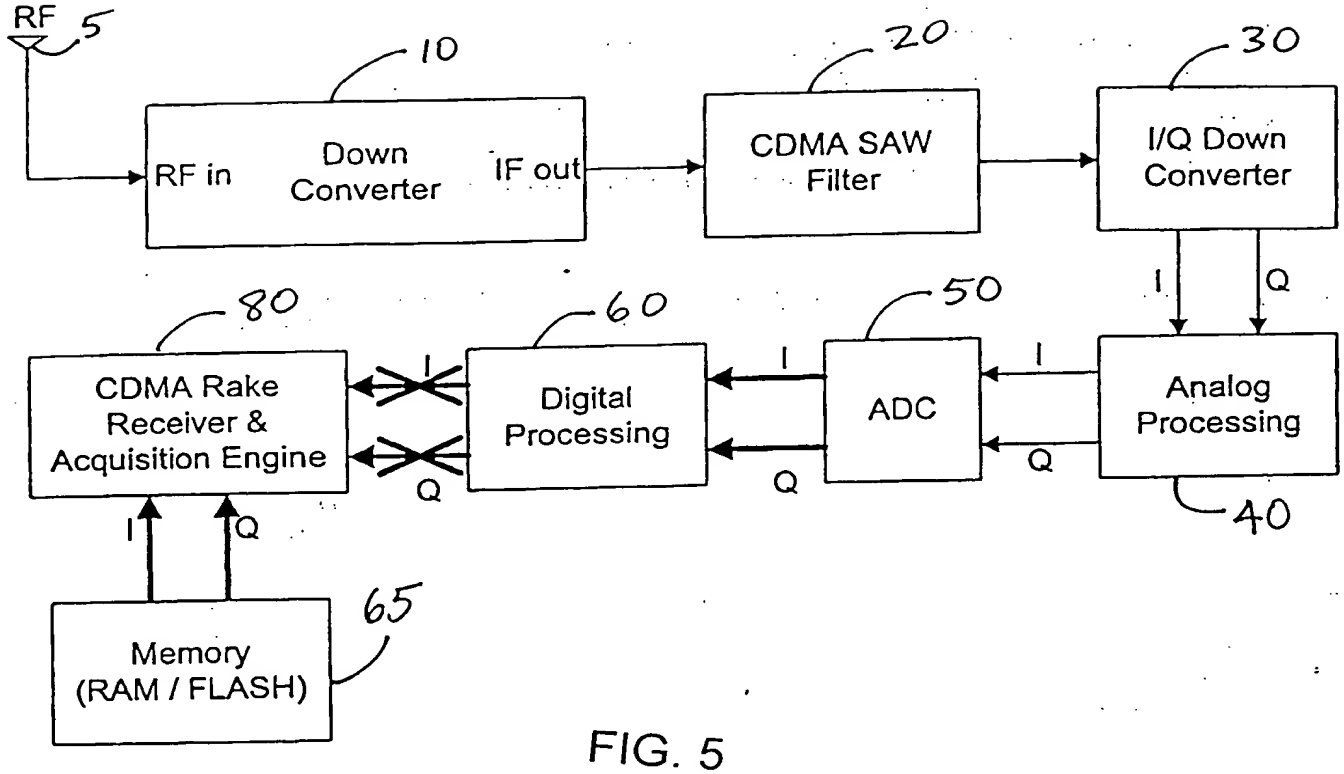
RF
5
10
20
30
RF in
Down Converter
IF out
CDMA SAW Filter
I/Q Down Converter
I
Q
80
60
50
CDMA Rake Receiver & Acquisition Engine
Digital Processing
ADC
Analog Processing
I
Q
I
Q
I
Q
40
65
Memory (RAM / FLASH)

FIG. 5

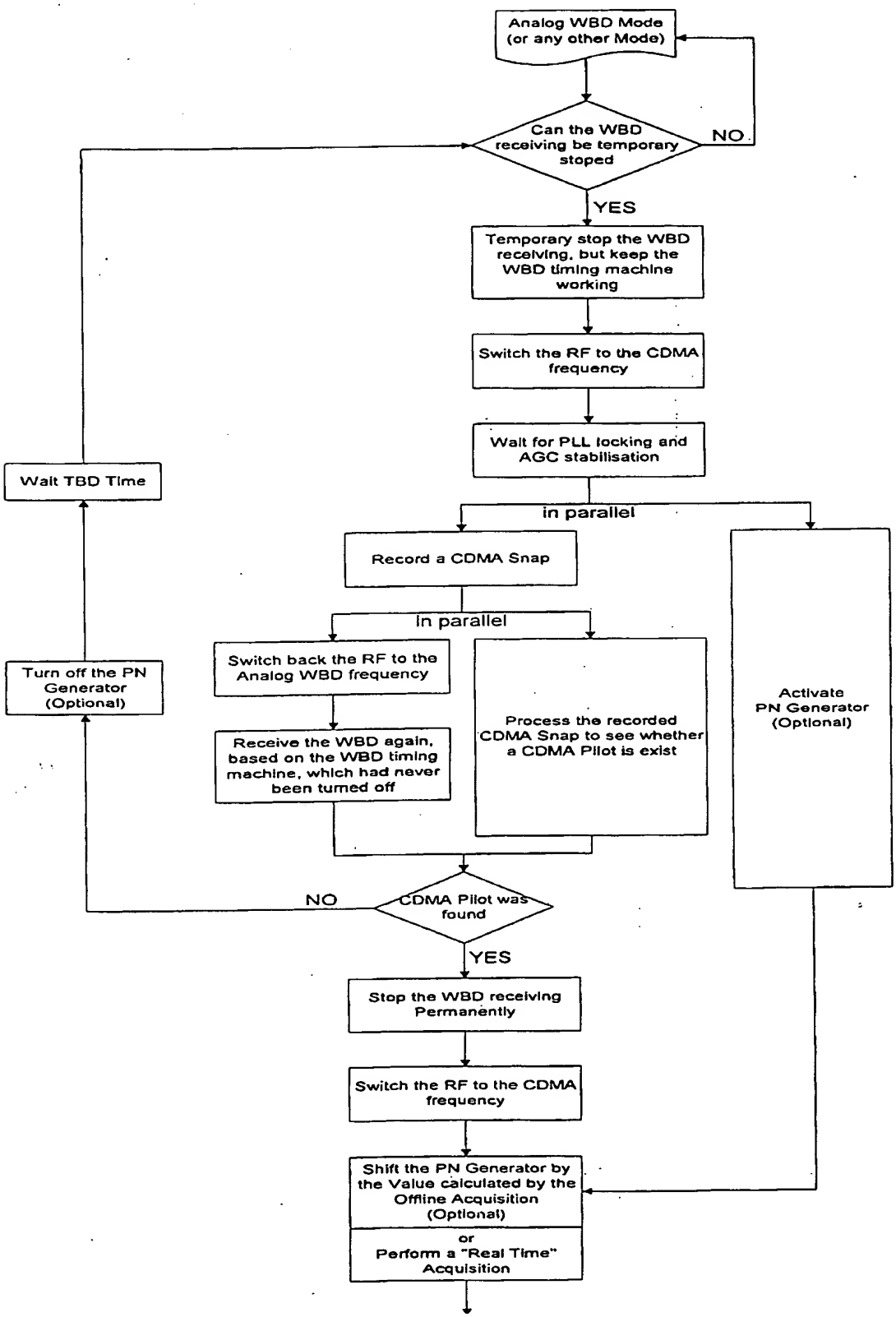
Analog WBD Mode (or any other Mode)
Can the WBD receiving be temporary stoped
NO
YES
Temporary stop the WBD receiving, but keep the WBD timing machine working
Switch the RF to the CDMA frequency
Wait for PLL locking and AGC stabilisation
Wait TBD Time
in parallel
Record a CDMA Snap
Activate PN Generator (Optional)
in parallel
Switch back the RF to the Analog WBD frequency
Process the recorded CDMA Snap to see whether a CDMA Pilot is exist
Turn off the PN Generator (Optional)
Receive the WBD again, based on the WBD timing machine, which had never been turned off
NO
CDMA Pilot was found
YES
Stop the WBD receiving Permanently
Switch the RF to the CDMA frequency
Shift the PN Generator by the Value calculated by the Offline Acquisition (Optional)
or
Perform a "Real Time" Acquisition

Fig. 6

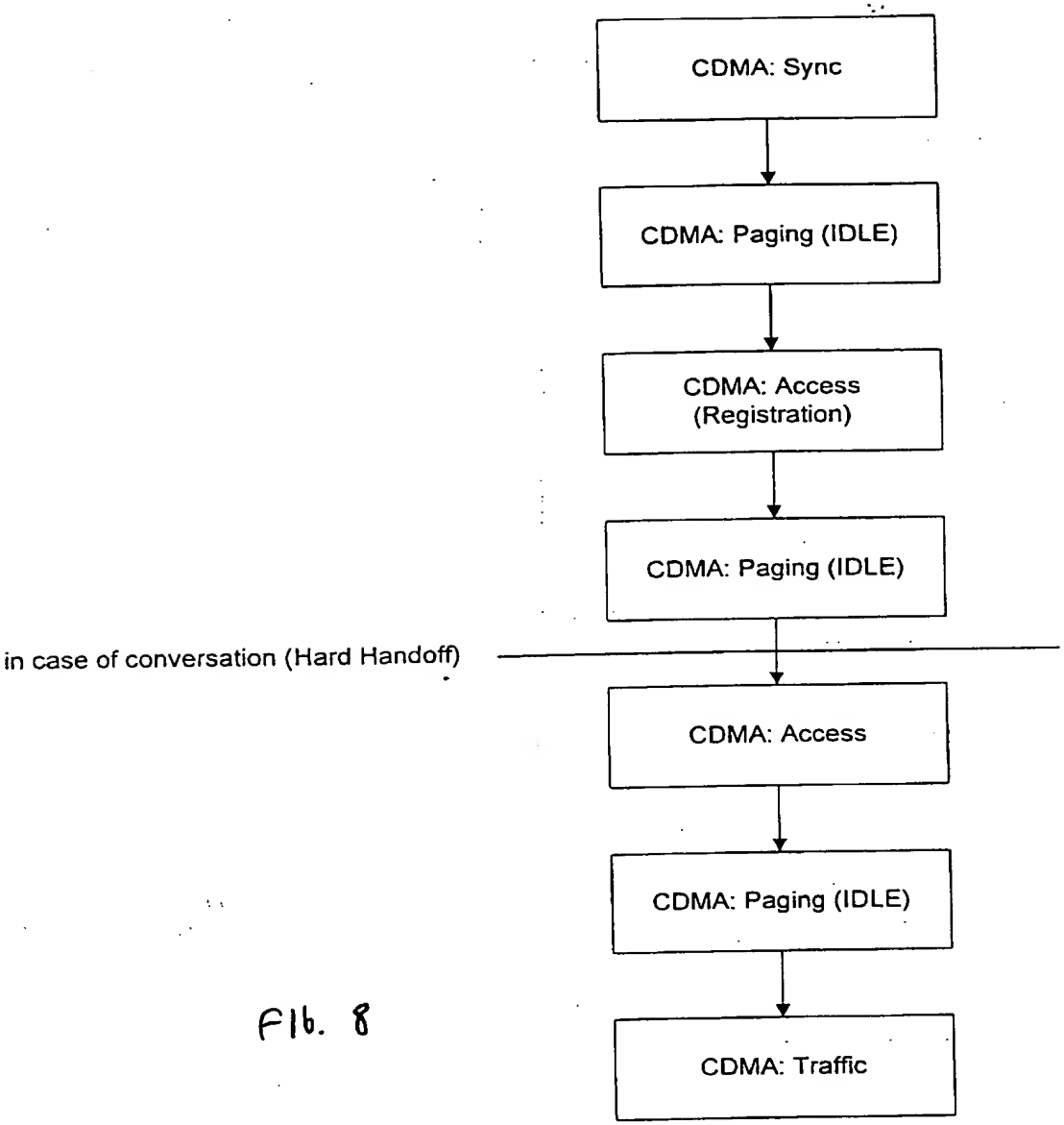
CDMA: Sync
CDMA: Paging (IDLE)
CDMA: Access (Registration)
CDMA: Paging (IDLE)
in case of conversation (Hard Handoff)
CDMA: Access
CDMA: Paging (IDLE)
CDMA: Traffic

Fig. 8

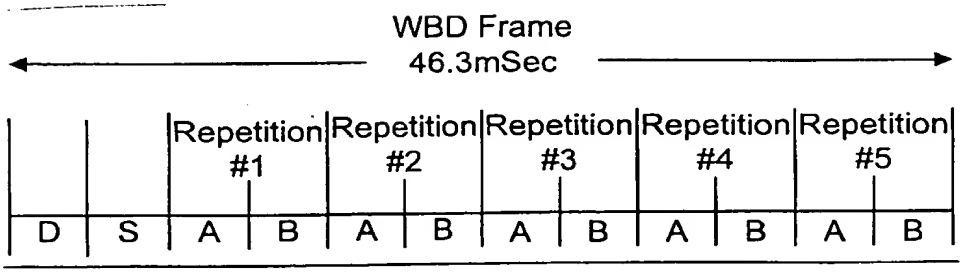
WBD Frame
46.3mSec
Repetition #1
Repetition #2
Repetition #3
Repetition #4
Repetition #5
D
S
A
B
A
B
A
B
A
B
A
B

Fig. 7